

What is claimed is:

- 1 1. A ninety degree coupler comprising: a four port device, a first transformer
2 winding connected across a first pair of ports, a second transformer winding being
3 coupled across a second pair of ports, said windings being tightly coupled in-phase, and
4 first and second capacitors each connected from one end of a primary winding to an
5 opposite end of the secondary winding.
- 1 2. The coupler according to claim 1 wherein said windings are provided with a
2 mutual inductance of $M \geq L$, where L is the inductance value of a winding.
- 1 3. The coupler according to claim 2 each of said capacitors has a value of c and
2 wherein the values of L and C are selected to provide a phase difference between the
3 second pair of ports of substantially ninety degrees.
- 1 4. The coupler according to claim 3 wherein values of L and C are selected to
2 provide the phase difference over a pre-selected range of input frequencies.
- 1 5. A four port coupling device including ports 1, 2, 3 and 4, port 1 for receiving an
2 input signal, and having an output appearing across ports 2 and 3 and the input appearing
3 across ports 1 and 4,
4 a transmission line capacitor coupled between each port and ground,
5 a first transformer having a first winding connected between ports 1 and 2 and a
6 second winding connected between ports 3 and 4, said first and second windings being
7 coupled in phase, a second transformer having a first winding connected across ports 1
8 and 4 and a second winding coupled connected across ports 2 and 3, said windings of
9 said second transformer being coupled in phase.
- 1 6. The coupling device of claim 5 wherein the windings of said first and second
2 transformers respectively are closely coupled.

7. The coupling device of claim 6 wherein each winding of the first transformer has an inductance of 33.5 nH, each winding of the second transformer has a value of 47.5 nH and said capacitors each have a capacitance of 45 pF, whereby phases of substantially 90° and 180° respectively are provided at ports 2 and 3 at an input frequency of 170 MHz.
8. The coupling device of claim 6 wherein each winding of the first transformer has an inductance of 2.8 nH, each winding of the second transformer has a value of 3.9 nH and said capacitors each have a capacitance of 3.9 pF, whereby phases of substantially 90° and 180° respectively are provided at ports 2 and 3 at an input frequency of 2 GHz.
9. A method of providing a 90° phase difference across ports 2 and 3 of a four port coupling device in which the input is applied to port 1 and appears across ports 1 and 4, comprising the steps of: splitting the input at each port between one inductor connected in series to a next port and another inductor connected to a previous port, coupling the windings between ports 1 and 3 and 2 and 4 respectively in phase, coupling the windings connected between ports 1 and 4 and 2 and 3 respectively in phase, and providing a capacitor coupled between each port and ground to form a transmission line.
10. The method of claim 9 further comprising utilizing the coupling device as a low pass filter.